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ABSTRACT

This paper reviewed literature on cognition to help art teachers understand what they can learn from the huge body of literature that has been generated by cognitive psychologists. It is argued that, in this information society, teaching memorization skills is not enough; students must learn problem-solving skills. A long list of specific thinking processes that have been researched is reported, and it is noted that many cognitive psychologists have attempted to compare the problem-solving processes of experts with novices. Experts, it is concluded, spend much more time than novices on improving the meaning of what they write, or on analyzing a problem. Experts use pattern recognition based on abstract principles. In addition, a major difference between experts and novices centers on metacognitive functioning, one of the most consistent themes in cognitive psychological research. Art teachers usually work with individual students to understand their cognitive approaches; this metacognitive approach ensures that the quality of the performance is assessed, rather than just the finished product. Analogic reasoning, metaphors, and synetics are also reviewed. Research about intuition as cognition and the use of symbols as they relate to cognition and art are described, and the advantages of active applications of knowledge are identified. The final sections of the document address problem-solving as central to cognition; better cognitive skills result in more effective problem-solving skills. The advantages of art include engaging the imagination, fostering flexible ways of thinking, developing disciplined effort, and building self-confidence. (KM)

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COGNITION: WHAT WE KNOW AND WHAT IT MEANS FOR ART TEACHERS

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by

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Cognition: What We Know and What it Means for Art Teachers

One day, our high school in Indiana received a phone call from a local musical instrument case manufacturer wanting to know if we had any art students who were looking for a job. We, quite understandably, asked what sort of art work would be required in this job. Not art work, was the reply, just assembling instrument cases. Well then, why art students, came our response. "Because," the manufacturer explained, "Only people who study art seem to understand craftsmanship."

We were gratified to learn that all the struggles with our students to refine and finish their art projects had resulted in recognition from such an unexpected quarter. But reflection on that experience reminds us that art has much transfer value. Much of what we try to teach in our art classes enhances the school curriculum as a whole and reinforces the values of society as well as sustaining the intrinsic benefits of art itself.

Recently, educators have realized that far too much attention in schools has been given to low level thinking, memorization, and the acquisition of discrete bits of information as if life were a Trivial Pursuit game or a quiz show program. In reaction against such fragmented educational practice, leaders in education have begun to call for greater attention to be given to the higher order thinking skills, sometimes referred to as "HOTS."

How to think is being stated as more important than just acquiring knowledge. Basic literacy is not sufficient for an adequate education. The sheer quantity of data generated by the recent information explosion as well as the efficiency of data storage technology such as computers has made memorizing information as a method of developing understanding obsolete and impossible to achieve. The answer being advocated is to develop higher

thinking skills so that this mass of information available to us can be processed in some managable manner.

This higher level thinking is referred to as cognition. Engel (1978) defined cognition as being "the mental activity of creating, perceiving, using, and enhancing--that is, learning--these structures" (p. 26). This term, cognition, is not precisely defined, as Perkins (1978) noted, but rather is at least as ambiguous as many works of art.

There is a huge body of literature that has been generated by cognitive psychologists, as can be seen by the bibliography accompanying this article. There is even a journal entitled Cognition. Examination of the Psychological Index, the Education Index, or the ERIC files, turns up huge numbers of listings. We must conclude, then, that much has been studied and learned about cognition. Consequently, we need to understand what art teachers can learn from all this study and literature.

Thinking More Important than Knowledge

Costa (1989) discussed the needs of an era of vast quantities of available knowledge. Literate citizens will no longer be judged by how much they know. It is no longer possible, Costa pointed out, to cover all information even in a lifetime. It has become necessary, consequently, to learn how to solve problems, think creatively, and continue to learn.

To be sure, teachers have always believed that students cannot think if they know nothing to think about. Resnick and Klopfer (1989) called for an education system that not only provided basic literacy, it also produced competent thinkers. "The entire educational program must be reconceived and revitalized so that thinking pervades student's lives from kindergarten onward, in mathematics and history, in reading . . . and art" (p. 2). They

stated that knowledge that comes from memorizing is not real knowledge and cannot be used. Nonetheless, they clarified that knowledge should possess a central place while thinking- and meaning-centered learning is taking place. But students must elaborate and question what they are told, examine new information in relation to other information, and build new knowledge structures so they can use knowledge to interpret new situations, to solve problems, and to think, to reason, and to learn.

Even mathematics educators, Kaplan, Yamamoto, and Ginsburg (1989) reported, have shifted away from back-to-basics drill and practice toward developing children's problem-solving and critical-thinking skills. In fact, they said focusing on rote memory early can be harmful because it may produce pressure and anxiety. Memorizing may mislead students into thinking that facts are not supposed to make sense but are just to be memorized like phone numbers.

Variety of Cognitive Operations

The first thing that we can observe in this literature is that a very long list of specific thinking processes or cognitive operations has been reported. This list includes interpretation (Madeja, 1978; Vuyk, 1981; College Entrance Examination Board, 1983; Wolf, 1985; Gardner, 1988; Hull, 1989; Minstrell, 1989; Resnick & Klopfer, 1989), questioning (College Entrance Examination Board, 1983; Vuyk, 1981; Bransford & Vye, 1989; Minstrell, 1989; Resnick & Klopfer, 1989), trying possibilities (Wolf, 1985; Resnick & Klopfer, 1989), demanding rational justifications (Kaplan, Yamamoto, & Ginsburg, 1989; Minstrell, 1989; Resnick & Klopfer, 1989), finding meaning (Beittel, 1972; Gardner, 1977; Olson, 1978; Costin, 1986; Simon, 1986; Dufresne, 1988; Berger, 1989; Bransford & Vye, 1989; Crowell, 1989; Davey, 1989; Hull, 1989;

Kaplan, Yamamoto, & Ginsburg, 1989; Minstrell, 1989; Resnick & Klopfer, 1989), elaborating upon new information (Gray & Lochhead, 1980; Wolf, 1985; Marzano & Arredondo, 1986; Minstrell, 1989; Resnick & Klopfer, 1989), critically analyzing (Vygotsky, 1971; Korzenik, 1977; College Entrance Examination Board, 1983; Wolf, 1985; Costin, 1986; Davey, 1989; Resnick & Klopfer, 1989), applying abstract principles to practical activities (Vuyk, 1981; College Entrance Examination Board, 1983; Belz, 1988; Bransford & Vye, 1989; Kaplan, Yamamoto, & Ginsburg, 1989; Minstrell, 1989; Resnick & Klopfer, 1989), clarifying the purposes of a task (Palincsar & Brown, 1989), evaluating for internal consistency (Browne & Keeley, 1988; Larkin & Chabay, 1989; Palincsar & Brown, 1989), judging the relative importance of ideas (Wolf, 1985; Picton, Stuss, & Marshall, 1986; Posner & Friedrich, 1986; Bransford & Vye, 1989; Palincsar & Brown, 1989), condensing or summarizing information (College Entrance Examination Board, 1983; Palincsar & Brown, 1989), organizing information by generalizing, categorizing, classifying, or pattern recognition (Beittel, 1972; Olson, 1978; Gray & Lochhead, 1980; College Entrance Examination Board, 1983; Arnheim, 1986; Friedman & Cocking, 1986; Marzano & Arredondo, 1986; Posner & Friedrich, 1986; Simon, 1986; Squire, 1986; Vosniadou, 1988; Bransford & Vye, 1989; Palincsar & Brown, 1989; Resnick & Klopfer, 1989), revision (Engel, 1978; College Entrance Examination Board, 1983; Wolf, 1985; Bransford & Vye, 1989; Crowell, 1989; Hull, 1989), identifying the social context of a task (Hull, 1989), clarifying initial ideas (Minstrell, 1989), identifying limitations (Minstrell, 1989), prediction or extrapolation (Marzano & Arrendondo, 1986; Minstrell, 1989), reflecting on implications (Gardner, 1977; Gray & Lochhead, 1980; Brown, 1988; Bransford & Vye, 1989; Minstrell, 1989), assessing misconceptions (Bransford & Vye, 1989),

invention or innovation (College Entrance Examination Bjoard, 1983; Wolf, 1985), translation or transformation (Vygotsky, 1971; Gardner, 1977; Csikszentmihalyi, 1978; Engel, 1978; Olson, 1978; Gray & Lochhead, 1980; Pinker, 1984; Wolf, 1985; Brown, 1988; Gardner, 1988; Roukes, 1988), integrate or synthesize (Vuyk, 1981; College Entrance Examination Board, 1983; Wolf, 1985; Marzano & Arredondo, 1986; Belz, 1988; Roukes, 1988; Brandt, 1989; Crowell, 1989), ability to focus on definitional issues (Browne & Keeley, 1988), recognizing ambiguities (Browne & Keeley, 1988), identifying assumptions (College Entrance Examination Board, 1983; Browne & Keeley, 1988) identifying value preferences or distinguishing between fact and opinion (College Entrance Examination Board, 1983; Marzano & Arrandondo, 1986; Browne & Keeley, 1988); apprension and valuing the qualitative dimension of life (Wolf, 1985); divergent as well as convergent thinking (Belz, 1988; Brown, 1988); evaluation based on external criteria (Vuyk, 1981; College Entrance Examination Board, 1983); using inductive and deductive reasoning (Madeja, 1978; College Entrance Examination Board, 1983); recognizing fallacies in reasoning (College Entrance Examination Board, 1983); drawing reasonable conclusions from information (College Entrance Examination Board, 1983); evaluating for compatibility with prior knowledge and common sense (Wolf, 1985; Crowell, 1989; Kaplan, Yamamoto, & Ginsburg, 1989; Minstrell, 1989; Palincsar & Brown, 1989) and identifying causal, spatial, and temporal relationships (Vuyk, 1981; Friedman & Cocking, 1986; Berger, 1989).

Comparing Experts and Novices

Many cognitive psychologists have compared experts and novices to determine the differences between how skilled and less-experienced

individuals engage in problem-solving. Beck (1989) studied these differences in the context of basketball players dribbling the ball. The novice was so preoccupied with the fundamentals of dribbling, he cannot attend to passing and shooting. In contrast, the expert dribbler hardly thinks about that process and concentrates on higher-level activities like avoiding a steal, passing, and shooting.

Schoenfeld (1989) used elapsed time as a method of comparing the processes of expert mathematicians and novices. Students, he found, spent most of their time in exploration, whereas, the experts distributed most of their time working on difficult problems among analysis, planning, implementing, and exploration.

Hull (1989) compared expert and novice writers. The experts spent much more time than the novices on improving the meaning of what they wrote. Novices were found to be bogged down in correcting spelling and grammar rather than improving other aspects of the writing.

Bransford and Vye (1989) discovered that experts use pattern recognition based on abstract principles. The inexpert tended to group problem material according to specific, concrete characteristics. Simon (1986) also observed that experts recognized familiar features in a problem that become the basis for correct handling of the situation. Bransford and Vye also reported that experts were better able to monitor their own thinking processes and could apportion their time more effectively than the novices could. The researchers suggested that these findings could be generalized to all areas of expertise. They noted that people are most often called upon to deal with new rather than familiar situations. The experts had the skills for this practical application.

Hardiman, Dufresne, and Mestre (1988) reported that experts were more able to detect the deep structure of a problem than novices. The deep structure involved identifying principles and concepts that might be keys to solving a problem. Novices tend to be distracted by surface features like jargon and descriptor terms as criteria for classification. Looking for the deep structure of a problem consists of detecting similarities which are related to procedures and principles leading to the solution. Hardiman, Dufresne, and Mestre regretted that "there is evidence that standard pedagogical practices do not incorporate this strategy" (p. 23). They urged that students be helped to learn how to organize knowledge and use effective problem-solving techniques in order to develop an overall conception of the structure of a subject.

Vosniadou (1988) noted that identifying within-domain and between-domain analogies between surface features and deep structure is an essential aspect of problem-solving. Being able to see the similarities between surface features and deep structures can become "a vehicle for discovering an analogy .... The richer and more tightly structured one's representation of a system is, the easier it becomes to see the structural similarities between it and other systems" (p. 16).

Marzano and Arredondo (1986) reported that cognition includes learning how to learn. One way of doing that is deep processing, which "provides students with a way of generating and exploring many different aspects of thought" (p. 2). "Deep processing is consciously generating these parts of a thought: the mental pictures, linguistic information, sensory information, and feelings" (p. 14).

Gray and Lochhead (1980) noted that "cognitive research contradicts the notion that student thinking is similar to that of ... teachers, just less

practical. The methods students use to solve a problem often bear no relationship to those intended by the problem's author" (p. 5). Clearly, they felt that there is a qualitative difference between the thinking processes of experts and novices. They urged further study of these differences in order to improve the teaching of more efficient thinking.

Gardner (1988) observed that comparing the artistic knowledge of skilled and unskilled individuals in how they handle and interpret artistic symbols reveals that differences do exist. Abilities vary in the ability to encode and decode artistic symbols. Gardner, of course, believes that there are at least seven forms of intelligence and that art abilities are embedded in several of these. He urges development of all of these abilities.

Friedman and Cocking (1986) offered the reassuring conclusion that instruction improves cognitive performance. This conclusion was the result of comparing the thinking of schooled and nonschooled individuals on a variety of cognitive processes such as pictorial literacy, perceptual illusions, eidetic imagery, logical problem-solving, and so on.

Metacognition

A major difference between experts and novices seems to center metacognitive functioning, according to Bransford and Vye (1989). One of the most consistent and persistent themes in cognitive psychology research involves this concept. Palincsar and Brown (1989) explained metacognition as "self-regulatory activity" in which we know "our own learner characteristics and the task demands" which enables the student "to select, employ, monitor, and evaluate the use of strategies" (p. 20). Schoenfeld (1989) defined matacognition as referring "to people's understanding about their own thought processes" (p. 94). Metacognition is achieved through

self-regulation that primarily involves "keeping tabs on your current state, and doing something different if warranted" (p. 95).

It is interesting to observe that processes that contribute to learning such as metacognition as studied by cognitive psychologists who commonly focus on learning processes in mathematics and reading are frequently taking place quite naturally in studio art instruction conducted by competent art teachers. Art teachers usually approach individual students and ask them what they are doing, why they are doing it that way, and how they think it will turn out.

Schoenfeld noted that students are unaware of or fail to use metacognition. He recommended that metacognition needed to be included in instruction and that it can be successfully taught through a coaching approach. He suggested interrupting individual students at work and posing the following questions.

> What exactly are you doing?
>
> (Can you describe it precisely?)
>
> Why are you doing it?
>
> (How does it fit into the solution?)
>
> How does it help you?
>
> (What will you do with the outcome when you obtain it?)
>
> (p. 98)

Such an analysis of processes, as suggested by Schoenfeld can, as noted by Larkin and Chabay (1989), assist a teacher in providing feedback to students on ways to achieve detailed improvements in execution or their choices of operations. Trawick (1988) advocated metacognitive control of learning by monitoring how one acquires, retains, and retrieves information. This self-regulated learning is "the highest form of cognitive engagement

students can use in school" (p. 5). Cocking (1988) observed that "metacognitive skills . . . enable one to monitor behavior and thoughts about behavior" (p. 3). Belz (1988) described meta-cognition as a "mental self-awareness during a learning task" (p. 8). Friedman and Cocking (1986) observed that students need to "become aware of their own cognitive strategies" (p. 327). Roukes (1988) observed that "creative output increases when people become aware of the psychological processes that control their behavior" (p. 11).

Bransford and Vye (1989) reported that cognitive scientists assume "that new knowledge must be actively constructed by learners" (p. 188). To the contrary, the two authors observed that "one cannot simply 'transmit' to students the secrets of expertise" but rather, "students must have the opportunity to actively use this information themselves and to experience its effects on their own performance" (p. 188). Bransford and Vye said that failure to provide opportunities to students to apply new information to specific goals will result in "inert" knowledge, that is, knowledge that can be applied only when prompted but which cannot be applied in new situations on a student's own initiative. These authors recommended that a coaching process that required students to think aloud as they attempt to solve various problems. Another metacognitive strategy is to talk over methods used with others who attempted to solve the same problem. It is also important, according to Bransford and Vye, that students see models of experts while they are solving novel problems. Morra, Moizo, and Scopesi (1986) concluded that teaching children to do artwork using a cognitive approaches should emphasize processes rather than products. By this, they mean that focus should be on detailed analysis of specific task demands and

processing factors rather than on general stages of development such as those described by Piaget.

Cocking (1988) summarized metacognition as a five-step process: defining and setting the bounds of a task, analyzing the requirements and/or components that comprise the task, establishing a performance protocol if one were to execute the plan assuming the plan is to be enacted, setting the standards or criteria for determining when the plan has been achieved or approximated, and, finally, evaluating the quality of the results of what one set out to do. This metacognitive approach insures that the quality of the performance is assessed, not just the proficiency or the efficiency of the final product. This is a qualitative judgment of behavior about which too little is considered in competency models of cognition. Crowell (1989) observed that in the past, a sharp distinction had existed between content and process, information and method. A metacognitive paradigm, however, makes the distinction between content and process less useful. Crowell noted that process was more than method but rather manipulating content to extend its relationships. Content and process become inseparable from each other.

The College Entrance Examination Board (1983) stated that proper studying included the ability to set study goals and priorities and then judge one's own progress toward those goals. Wittrock (1986) confirmed that a meaningful approach to cognition was process-oriented. He indicated that the process was self-monitoring. David Perkins (Brandt, 1990) indicated that "we need to equip kids with the kinds of patterns of thinking--thinking organizers, if you like--that help them to manage their thinking and their learning" (pp. 51-52). Perkins called this kind of thinking patterning "thinking frames" which he defined as "anything you use to guide, direct, or

shape your thinking, including things like 'hang loose for five minutes'" (p. 52).

Analogic Reasoning

Another major skill that figures large in the cognitive literature is linking what is known to new information or analogic reasoning. Palincsar and Brown (1989) observed that abilities to created links between what is known and new information is one of the strategies that both monitor and foster comprehension. Kaplan, Yamamoto, and Ginsburg (1989) stated that focusing on relationships is more important than memorization. Minstrell (1989) indicated that higher thinking required that students successfully transfer conceptions to new situations. Fundamentally, this process means making comparisons. (Larkin & Chabay, 1989) To test this ability, we need to observe students using ideas in new multiple contexts. Morra, Moizo, and Scopesi (1986) urged a gradual development of procedures that increase the ability to apply cognitive strategies to more and more situations. The College Entrance Examination Board (1983) identified a basic study skill to involve synthesizing knowledge and applying it to new situations. Posner and Friedrich (1986) put it that training "in one domain might produce and improvement that would transfer to other domains" (p. 100). Wittrock (1986) said students should be taught "to construct relations between previously acquired knowledge and experience" (p. 159).

Marzano and Arrendondo (1986) stated that higher-order thinking skills include analogic reasoning. They explained it as "a process for solving specific types of problems in the format: A is to B as C is to D" (p. 3). .Vosniadou (1988) defined analogic reasoning as "the identification and transfer of an explanatory structure from a known system," the source, " to a

new and relatively unknown system." (p. 3) the target. She observed that the first step in such a process involves recognizing some similarity between the two systems. Pinker (1984) called for "imagining a concrete analogue of an entity, transforming it, and then translating it back to the original domain could make explicit certain properties and equivalences in that domain that were only implicit beforehand" (p. 57). Berger (1989) stated that an important method of transmitting meaning involves using analogies. He defined analogic thinking as suggesting that something is like or similar to something else. He reported that some scholars believe "that metaphor is the basic way we have of knowing about the world and that human thinking is essentially metaphoric" (p. 33). Of especial importance to art, Berger noted that metaphor is not confined to words and written language but is also part of visual language and is found throughout image making.

Roukes (1988) discussed the concept of synectics which comes from the Greek word synectikos, meaning bringing different things into unified connection. Synectics is essentially finding physical, psychological, or symbolic links between things, no matter how dissimilar they may be. Roukes listed numerous synectic trigger mechanisms that are tools for making analogic connections for creative thinking. Some of these synectic trigger mechanisms include combining, transferring, analogizing, hybridizing, and symbolizing.

Intuition as Cognition

Intuition is often regarded to be diametrically opposed to the whole idea of cognition, which is perceived as being a rational process while intuition is perceived as being irrational. But Rudolph Arnheim (1986) included intuition with the cognitive aspects of visual perception. This is because he

stated that perception is not just a "mechanical recording of the stimuli imposed by the physical world upon the receptor organs of man and animal, but the eminently active and creative grasping of structure" (p.xi). The structure is grasped by a field process, which is what intuition is, he reasoned. To be sure, this intuition works together with the intellect but intuition is an essential part of the cognitive process. "Intuition and the intellect are the two cognitive procedures. By cognition I shall mean here the acquisition of knowledge in the most comprehensive sense of the term" (p. 14). This is especially important in art, Arnheim argued, because proper analysis of art requires first intuitively grasping the aesthetic message before dealing with it intellectually as a work of art. Intuition is vital to understanding art as an organized whole. This is necessary to gain access to the symbolic meaning of art. Gestalt theory confirms that a whole is more than or different from the sum of its parts. This is important because "in successful works of art the most evident overall structure tends to symbolize the fundamental theme" (p. 7). Arnheim suggested that education that fails to teach intuition as thoroughly as the intellectual aspects of cognition would "cripple the minds we are trying to nurture" (p. 29).

Symbols in Art and Cognition

A central idea about art centers around the use of symbols in art. Gardner (1988) observed that art is an activity of the mind which involves the use of symbols, a cognitive operation. The "artistically-competent individual is one who is able to 'read' and to 'write' symbols" (p. 104). The emotions are instrumental in symbol encoding and decoding. The College Entrance Examination Board (1983) observed that art involves subtle meanings and complex systems of expression. As a result, decoding skills

are necessary to develop. Arnheim (1986) pointed out the necessity of learning the systematic skills to analyze the symbolic meaning of art. Vuyk (1981) confirmed that use of symbols is a cognitive function. This use of symbols, according to Douglas Heath (Brandt, 1989), is an essential part of being able to mature to reflective awareness. Roukes (1988) defined a visual symbol as being "a graphic device which stands for something other than what it is" (p. 20). To produce such symbolic images, artists must combine public symbols (well-known and widely understood) and private symbols (cryptic images having special meaning only to the artist). Berger (1989) indicated that symbolic visual expression is needed to develop and maintain our emotional states and creative impulses. They are needed to make our ideas "more real or concrete and to channel or focus our emotions more directly" (p. 1). Semioticians such as Peirce (Berger, 1989) identified three kinds of signs. An icon looks like or resembles what it stands for. An index is connected logically with what it indicates. A symbol has a conventional meaning and has no logical connection between the meaning and the image. The icon is easy to interpret. An index can be figured out logically. A symbol, on the other hand, requires learning the code, as it were, in order to make the interpretation. Symbols have tremendous power on people, like flags, the crucifix, logos, etc. "If everything in the universe is a sign or can be understood as one, it certainly makes sense to learn how to interpret and understand signs" (p. 29). Further, it should be noted that "if signs can be used to tell the truth, they can also be used to lie" (p. 30).

Madeja (1978) reminded us that June King McFee noted that cognition includes both perceptual and conceptual information-processing. Both of these processes can be expressed by the artist in iconic and verbal symbols to communicate with the viewer. "The symbols are the medium of

communication for the cognitive act" (p. 12). Engel (1978) indicated that "the arts are a form of knowledge, a symbolic and expressive system or structure. . . . the activity takes place within the form of a symbolic structure-set which both is and contains knowledge. The arts can therefore be understood as cognitive processes" (p. 26). Goodman (1977) observed that "even the purist's purest painting symbolizes" (p. 16). He explained that art symbolizes certain patterns, shapes, colors, and textures. Wilson and Wilson (1978) suggested that artistic symbols symbolize artistic symbols. Goodman concluded that art can be missing representation or expression or exemplification but it cannot be without all three.

Project Zero, founded at Harvard in 1966 by Nelson Goodman (Perkins & Leondar, 1977) to investigate the functioning of cognition with special emphasis on the arts, focused on symbol processing and its implications for education. They quoted Cassirer, the European semioticist, as arguing that the symbol systems of myth, religion, language, art, history, and science are the foundation of human culture. "Art, then, becomes above all an act of intelligence, whether overt, covert or unconscious, reflective or reflexive" (p. 7). Gardner (1977) defined symbol system as "a set of elements which have certain syntactic relations among themselves and which relate in specifiable ways to a field of reference" (p. 90). Interpreting a symbol system involves cognitive operations such as determining the meaning and implications rather than just surface manifestations. The symbol system, Gardner asserted, is a crucial part of sustained artistry. Olson (1978) stated that "'the arts' are no less symbolic than language and mathematics even if they often employ symbols having somewhat different properties from ordinary language" (p. 60). He noted that art uses the same symbols even though they may be used differently. "Symbols," he explained, "serve both as means

of exploring reality and as forms or modes of thought by being completely transparent to the semantic and logical structures they represent or exemplify" (p. 79).

Csikszentmihalyi (1978) pointed out the distinction between the uses of symbolism in science and in art. "Science acquires its power through the clarity and precision of its symbolic coding. Art, on the other hand, acquires its power through the symbolic representation of experience that is ambiguous, contradictory, or not fully emergent in consciousness" (p. 118). This artistic cognition uses holistic, idiosyncratic, and implied symbolic rules rather than explicit rules. "Art has different goals and different methods than science" (p. 120). "The key to creative achievement is the transformation of an intangible conflict into a tangible symbolic problem to which the creative solution will be the response" (p. 121). Consequently, Csikszentmihalyi asserted, cognition and emotion cannot be separated because art attempts to master ambiguous symbols rather than the unambiguous symbols reason relies on. He cautioned against dabbling in art without learning skills or commitment. Further, the student needs instruction that emphasizes sensitivity to inner feelings, skill development, and ways to develop visual symbols related to the student's genuine experiences.

Advantages of Holistic Task Work

Traditional apprenticeships have certain advantages over school. By active application of knowledge to real tasks, learning is more effective. Holistic task work is superior to practice of discrete tasks lifted out of context. Learning by doing is important because learning proceeds from the concrete and goes to the abstract.

Resnick and Klopfer (1989) studied apprenticeship learning models and concluded that traditional apprenticeships did have advantages over schools. The fact that an apprentice learns in the context of actual work prevents problems in understanding how to apply abstractions and theories to practical activities. Apprentices have "no temptation to substitute talk about skills for experience in actually using them" (p. 9). Tasks for apprentices are never lifted out of context. They may perform less complex tasks first but very little time is spent practicing discrete tasks. Apprentices also spend much time observing how the skilled perform the tasks. In manual labor situations, this is easy to arrange. For mental tasks, however, a conscious effort must be made to insure that the mental activities are made overt. Palincsar and Brown (1989) advised that real-world experience was an important part of the cognitive process. Crowell (1989) explained, using reading as an example, that learning discrete aspects of the reading process is not an effective way to learn to read. He cautioned against such fragmenting of reality and challenges by asking, "Is knowledge really confined to separate, distinct subjects that rarely relate to experiential reality?" (p. 60) The universe, he asserted, "is not a mechanical multiplicity of things. It is a single, dynamic unity" (pp. 60-61). Crowell complained that the school curriculum tells students that the world is divided into independent fragments that causes them to separate the thinking taught in school from any reality or meaning encountered in the world. He indicated that while we may focus on one thing at a time, the brain actually deals with many things at the same time. Crowell reported that "the brain processes parts and wholes simultaneously" (p. 62). Vygotsky (Friedman & Cocking, 1986) argued that the child learns to solve problems through opportunities to solve problems together with more expert individuals.

Kaplan, Yamamoto, and Ginsberg (1989) cautioned against teaching that relied on back-to-basics drill and practice that ignored the holistic task. Larkin and Chabay (1989) recommended that "it is necessary that the student work on full, complex tasks" (p. 161). Work on simpler, component, or prerequisite tasks is not as productive as it might appear, judging from its frequent use in school settings, because the full, complex task is most likely different in nature. Bransford and Vye (1989) indicated that cognitive scientists generally agree that new knowledge must be constructed by learners rather than it being transmitted. They have to actively use information to experience how it affects their own performance. Reading a textbook is not likely to achieve effective learning because "the new information does not replace previous misconceptions" (p. 194). A solution offered by Bransford and Vye is to shorten introduction time and increase the time spent solving the problem. The most effective teaching takes place in a coaching style while the student is working on the task. Dufresne (1988) indicated that "procedures must be taught in the context of problem situations, and extended to different kinds of situations" (p. 10). The College Entrance Examination Board (1983) stated that "just as thorough understanding of science requires laboratory or field work, so fully understanding the arts involves first-hand work in them" (p. 16). This is necessary, the College Board explained, because works of art often involve subtle meanings and complex systems of expression.

Hull (1989) reported that instruction in writing could be greatly improved if it involved marking and responding to finished products and working with authentic tasks rather than just drilling on separate operations within the task of writing. One could infer, from Hull's discussion of writing, that learning in any task is more productive if the work involved holistic

tasks aiming for finished products in which all the factors involved in effective writing and, we might add, art, and their meaningful interaction must come to play.

Minstrell (1989) urged that transfer be taught in school. This means that inconsistencies between their ideas and what actually happens must be reconciled. The intended result is to transfer what students learn in formal learning to everyday life and work situations. Emphasis needs to be placed on solving related problems. Bransford and Vye (1989) urged a transition from memory to action in order to bring about meaningful learning. New information must replace previous misconceptions to become effective learning. Resnick and Klopfer (1989) complained that tests too often are "collections of unconnected questions, rather than samples of extended problem-solving or reasoning activities" (p. 209).

Problem-Solving Central to Cognition

Ultimately, the primary purpose of thinking is to solve problems. The better the cognitive skills the more effective the problem-solving. Costa (1989) indicated that there is too much knowledge to learn these days so students need to be taught how to solve problems rather than try to memorize the information that is available. Resnick and Klopfer (1989) noted that problem solving is near the top of the hierarchy developed by Bloom.

Schoenfeld (1989) summarized the problem-solving processes a teacher should help students undertake. The teacher should help students accept the challenge of solving a problem. They should create a classroom atmosphere that encourages undertaking unfamiliar tasks. The teacher should give help without preventing students from finding their own ways.

Teachers should provide methods of solving problems. Finally, teachers should talk through the processes being used by their students in order to build up vocabularies and become conscious of the processes involved.

The test of learning effective problem-solving processes, according to Minstrell (1989), is to go beyond the problem originally learned and move on to related problems to insure that the problem-solving process is understood. Larkin and Chabay (1989) urged that it was essential to give students practice in problem solving for motivational reasons and "because learning to think requires practice in taking control and making choices" (p. 161). Bransford and Vye (1989) called for students having the opportunity to experience the complex processes and emotions of real problem solving. They recommended that students first try solving problems themselves. Then they should explain what they tried to do. This would open them up to face any misconceptions they may have held. Then students would be ready to learn appropriate strategies for solving problems.

Dufresne (1988) observed that thinking at the level of an expert required "building an overall conception of the structure of the domain" (p. 10) and that procedures for such thinking should be taught in the context of problem situations. These skills should then be applied in new situations in which the similarities to the familiar problem are identified. Fielding (1989) observed that children learn their problem-solving techniques from the cultural norms transmitted by adults. For children to learn how to solve artistic problems, Fielding asserted, they must be socialized by being introduced to the thinking and problem-solving behavior of artists. The College Entrance Examination Board (1983) indicated that the techniques of reasoning are very important for college preparation. This reasoning

included "the ability to identify and formulate problems, as well as the ability to propose and evaluate ways to solve them" (p. 10).

The Soviet psychologist and semiotician, Lev Semenovich Vygotsky (1896-1934), studied the cognitive development of children, laying much of the theoretical foundations for twentieth-century cognitive psychology. He created the concept "zone of proximal development" (Wertsch, 1985) which was the distance between a child's "actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 87). Consequently, the best way to teach children from the point of view of this theory would be to challenge students at a little above their developmental level. With instruction, Vygotsky was saying, students can learn more than they could on their own without instruction. Friedman and Cocking (1986) reported that Vygotsky said that children learn to solve problems by doing it with more expert individuals.

Roukes (1988) developed a system of synectics which he defined as "bringing different things into unified connection" (p. 11). Synectic thinking involved the ability of seeing a relationship between things no matter how dissimilar they may appear to be. These can be linked by synectic thinking in a physical, psychological or symbolic way. "It is a way of mentally taking things apart and putting them together to furnish new insight for the solution of problems in . . . art" (p. 11). Marzano and Arrendondo (1986) listed ten reasoning skills that were "commonly considered higher-order thinking skills" (p. 3). All of these are portions of the problem-solving process: analogical reasoning, extrapolation, evaluation of evidence,

examination of value, decision making, non-linguistic patterns, elaboration, solving everyday problems, solving academic problems, and invention.

Cognitive Operations Make Art Basic

Basic literacy, according to Resnick and Klopfer (1989), is necessary, but students are entitled to more from elementary and secondary education. They must develop thinking skills throughout the entire curriculum. Morra, Moizo, and Scopesi (1986) conducted experiments with children and drawing. They concluded that there was a direct relationship between general information processing and drawing skills.

Wolf (1985) indicated that "the arts engage individuals in 'hard work'" (p. 14). This hard work develops "a number of skills and competencies that are common to the full range of academic work" (p. 15). The College Board stated that "the arts must be treated as one of the six Basic Academic Subjects, because without intensive, carefully designed instruction few students can grow in artistic knowledge, skill, or imagination. . . . Ignorance of art is a form of illiteracy. . . . students need the special kind of knowing that makes work in the arts distinctive" (Wolf, 1985, p. 17). "The close examination of artworks may reinforce observational and interpretative skills akin to those used in the physical and social sciences" (p. 17). Gardner (1988) stated that "art is being seen anew--or once again--as a matter of the mind" (p. 104).

Gardner (1988) complained that too much attention has been given to linguistic and logical-mathematical forms of intelligence. Gardner said that work in the arts is important for educators to pursue. An advantage of art is that no matter how idiosyncratic an individual's thinking may be, there is an artform which they can develop effectively. If we want our children to

develop all their intellectual potential, "it is virtually an imperative that we facilitate involvement in one or more art forms" (p. 108). Fielding (1989) noted how the visual arts provide children with useful problems to solve.

The College Entrance Examination Board (1983) concluded that preparation in the arts is valuable for students entering college no matter what they may choose for a major. The advantages include engaging the imagination, fostering flexible ways of thinking, developing disciplined effort, and building self-confidence.

Arnheim (1986) found that visual perception was an important part of the mind's cognitive dealings with the world of reality. He defined intuition as cognition through perceptual field processes. "Together, intuition and the intellect produce thinking, which is inseparable from perception" (p. xi). Arnheim suggested that art teaching, to be cognitive in nature, must go beyond pointing out subject matter or identifying shapes and colors. To make art come alive, students must be taught to become systematically aware of visual forces of direction, relation, and expression so as to understand the symbolic meaning of art. "In successful works of art the most evident overall structure tends to symbolize the fundamental theme" (p. 7). "Drawing, painting, and sculpture, properly conceived, pose cognitive problems worthy of a good brain and every bit as exacting as a mathematical or scientific puzzle" (p. 146). "One of the great educational advantages of artwork is that a minimum of technical instruction suffices to provide students with the instruments needed for the independent development of their own mental resources" (p. 147). Arnheim described his dream university which would have a core curriculum of philosophy, studio art, and poetry. The philosophy would teach reasoning, the art would "refine the instruments by which to carry out such thinking" (p. 148), and the poetry

would make our language effective for communication. "The arts fulfill, first of all, a cognitive function" (p. 253) because we acquire all knowledge through our senses. As Vygotsky (1971) said it, "art requires brain work" (p. 32). Engel (1978) stated that the arts are distinctly cognitive, involving mental activity analogous to logical, semantic thought" (p. 23).

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